Aquatic-dwelling Weevils.

IN NATURE of September 6 there is a note (p. 472) on Dr. Nelson Annandale's papers on the fresh-water fauna of India, ending with the words "an aquatic weevil, which, so far at any rate as habits are concerned, is altogether unique." If this sentence is intended to mean that water-dwelling weevils were previously unknown it is incorrect.

Mr. J. H. Keys and myself took specimens of the weevil *Eubrychius velatus*, Beck, from a pond near Plymouth in September, 1905, which were as thoroughly aquatic as any of the typical water-beetles (*e.g.* Dytiscidæ), most of their time being spent in crawling under water on the leaves and stems of Myriophyllum. Fowler has an interesting note on this species, to the same effect, in his "Coleoptera of the British Islands," vol. v., p. 373.

Mr. Keys also states that *Tanysphyrus lemnae*, F., and the various species of Bagous are all more or less aquatic.

E. E. LOWE.

Museum and Art Gallery, Beaumont Park, Plymouth, September 11.

Remarkable Rainbow Phenomena.

THE letter of Mr. M. Spence in NATURE of September 20, describing a bifurcated rainbow, reminds me of a similar phenomenon which I saw some time during the winter of 1897–8. On that occasion the phenomenon was not so complete as that described by Mr. Spence, only the left-hand portion of the bow being visible. The arch rose from the horizon as a single column to a height of about ten degrees, and then bifurcated into two distinct branches, which, however, did not extend far from the join.

As I was playing in a football match at the time it was impossible to study the effect at all closely; but, so far as I remember, the lower branch sprang out of the main regular bow, making with it an angle larger than that described by Mr. Spence. My incomplete observations were not alone of much value, but in confirmation of Mr. Spence's fuller description they may be worth recording now.

GEORGE C. SIMPSON.

Manchester University.

Is it not the case that the second rainbow seen by your correspondent (p. 516) was caused by the reflection of the sun in the sea? If this were so, naturally persons some miles west of Deerness, or inland, would not have seen it. I once saw the appearance of double rainbows beautifully manifested in Ranenfjord, on the coast of Norway, and the explanation which I have given is that which found most favour with the passengers on our steamer.

C. S. TAYLOR.

Banwell Vicarage, September 21.

SOME SCIENTIFIC CENTRES.

IX.—THE METALLURGICAL DEPARTMENT OF THE SHEFFIELD UNIVERSITY.

NEARLY fifty years ago Sir John Brown, the famous engineer and steel manufacturer, with Dr. H. C. Sorby, the father of the introduction of the microscope for the examination of thin sections of rocks and of polished or polished and etched surfaces of iron and steel, attempted to establish in Sheffield a school of practical science; but as yet Britain held undisputed sway in the world of engineering and of metals; and the help of science, proffered by these far-seeing men, although just as desirable then as now, was rejected by such easy victors in the wars of commerce. The sum of 200*l.* was spent in advertising, with the result that only one student entered. Several years' perseverance never produced more than five students, so far as Dr. Sorby's memory serves him. Sixteen years later the added personal influence of such men as Mr. Mark Firth, Sir Frederick Mappin, Sir Henry Stephenson, and Mr. J. F. Moss failed to find a response, and although in 1879 Mr. Mark Firth founded Firth College to facilitate university extension work, it was not until 1883 that another special meeting was held, at which Dr. Sorby used the following pregnant words: "I do not see why we should not make the teaching of metallurgy a speciality of the town, nor why we should not make Sheffield the centre of metallurgical instruction."

In 1885 the Sheffield Technical School was fairly launched in a separate building, but as a department of Firth College, with chairs of engineering and of metallurgy both held by the late Prof. W. H. Greenwood. Until 1889 the department of metallurgy was in connection with the Science and Art Department, and its work consisted of courses of lectures on fuel, refractory materials, iron, steel, and general metals, with assaying and experiments in a laboratory fitted with analytical benches, wind and muffle furnaces similar to those in the Royal School of Mines of that date. In 1889, Prof. Greenwood having resigned his chairs to undertake the management of the Birmingham Small Arms Factory, John Oliver Arnold was appointed to the chair of metallurgy which he holds to-day. He began at once to inaugurate revolutionary changes, the fundamental aims of which seemed to be: (1) to increase the science of the metals themselves, the art being then in great preponderance; (2) as the industries of the district were mainly of iron and steel, to pay special attention to these, assured that science could be as truly served and minds as fruitfully trained on metals of immediate interest to the district as on the wider range; and (3) to keep the ideal ahead of having available on a small scale, but by a manufacturing method as distinct from a laboratory method, examples of as many types of metallurgical processes as possible, so that the students might examine the whole course of each process from beginning to end in the comparative calm of an educational establishment. A start was made by erecting a two-hole crucible steel-melting furnace fully equipped as a small works, and differing only from the large works in the city in that theirs would consist of so many dozens or hundreds of holes of the same size. The effect on the attendance was electrical, and the available laboratory accommodation was at once completely filled. A difficulty here arose in that the Science and Art Department objected to the course, but a very simple solution was found in cutting the laboratory adrift from Government control, the public men supporting it guaranteeing against any resulting financial difficulty. It ought in justice to be said that in those days the department did sounder work for pure science than it seems to be the present fashion to acknowledge, although its influence on metallurgy in Sheffield was not good.

The complete success of this first part enabled Prof. Arnold to induce the members of the governing committee to commence the more ambitious part of his scheme, though with some misgivings, and during the session 1890–91 the students had the rare privilege of following the erection of, as well as working, plant consisting of a 25 cwt. acid Siemens furnace, with gas producers and all necessary hydraulic power for lifts, a No. ½ Stewart rapid cupola, foundry with drying stove for sand and "compo" moulds, and a falling weight test apparatus. As showing the curious features which sometimes govern a problem, although the No. ½ cupola worked well it had soon to be replaced by a No. 1, as when the lining began to wear it was only with the utmost difficulty that even a temporary assistant of the staff could be obtained sufficiently attenuated to be able to effect the necessary repairs, and at any time inspection of the lining was somewhat of an acrobatic performance. A 50-ton Wicksteed mechanical testing machine for tensile, trans-

verse, crushing, bending and torsion tests was installed jointly with the engineering department under Prof. W. Ripper, and whilst this machine formed a solid meeting ground it may also be considered as emblematic of the relationships existing between these two departments from the beginning, namely, that the metallurgical should, so far as possible, make all metallic materials for the engineering department, and in return know of the behaviour of the materials supplied.

In 1890 the technical school, apparently finding it too difficult to impress its needs on the college authorities, became an independent institution, and was thus free to work out its own ideals until 1896, when the two again joined for the purpose of applying for a charter to become a university college, which charter was received in May, 1897. That its isolated progress produced a result acceptable, not only to practical, but to university men, was shown when application was made to enter the then Victoria University (an application to the making of which the present writer was firmly opposed); the report of the University Commission as published in the newspapers distinctly stated that the technical department was the only part fit for inclusion in the university.

It is impossible justly to estimate the influence of the metallurgical department, but the task must be attempted, as therein lies its soul. Thirty or so researches worked out in the department have been published by Prof. Arnold, his staff and students since 1889. "The Influence of Aluminium on Occluded Gases in Steel" (Arnold) was the first subject attacked, because of the many conflicting statements as to this influence. The experience gained in this work made possible the manufacture of a series of extraordinarily pure steels, the first research on which resulted in "The Influence of Elements on Iron" (Arnold), which combated Roberts-Austen's atomic volume theory as applied to steel, and Osmond's theory of the hardness of steel being due to a flint hard β iron apart from any carbon contained. Incidentally the micro-constituents FeS and MnS were discovered. The almost pugilistic vigour of the tone of this paper and criticisms which had preceded it seemed to turn many listeners, used to more gentle ways, into opponents without examination of the arguments, and it undoubtedly took many years to dispel the feeling, which still remains in the minds of some of the more unthinking or erratic, as seen from the way in which in a recent paper simple quotations from a well-known writer were treated in the discussion as attacks on him. "The Chemical Relations of Carbon and Iron" (Arnold and Read, 1893) was the result of work done to examine the discovery of the carbide of iron by Abel and Müller, and their results were fully confirmed, the carbide being obtained in chemically pure crystalline plates. In 1895, in "The Influence of Carbon on Iron" (Arnold), the discovery of the saturation point of steel was

FIG. 1.—Prof. J. O. Arnold in the Micro-laboratory.

announced, and the quantitative composition of Sorby's pearly constituent determined. This paper is admitted on all sides to be a classic.

In 1896, in "The Influence of Impurities on Gold and Copper" (Arnold and Jefferson), the first micrographic investigation of gold alloys was described, and the discovery of brittle intercrystalline cements rendered void atomic volumes as an explanation of the results. 1897 produced "The Influence of Sudden Cooling on Nearly Pure Iron" (Arnold), and "The Permeability of Steel-melting Crucibles" (Arnold and Knowles), which showed a method for quantitatively measuring the volume of gas permeating the walls of crucibles ¾-inch thick during metallurgical operations. "The Micro-chemistry of Cementation" was read in 1898, and the discovery of the cause of the decay of certain metals used in marine construction in connection with the disastrous explosion on the S.S. *Prodano* was given in a report to Lloyd's. "The Diffusion of Elements in Iron" (Arnold and McWilliam, 1899) divided the elements of steel into fixed and migratory groups and confirmed Prof. Campbell's diffusion of sulphide phenomena. During this research two very important phases of carbide interpenetration at different temperatures were discovered, and also a hitherto unsuspected segregation point which has cleared up some of the occasional mysterious failures of the highest grade cutting edge steel.

"The Properties of Steel Castings, Part i." (Arnold, 1901) dealt with pure iron and carbon castings, and showed their unsuitability for general commercial work. "The Micro-structure of Hardened Steel" (Arnold and McWilliam, 1902), amongst other things, first showed the cementite in the so-called austenite martensite structure. "The Elimination of Silicon in the Acid Open Hearth" (McWilliam and Hatfield, 1902) is an interesting study, under works conditions, of chemistry at high temperatures in the reaction of metal and slag on each other, in which a balance point in the composition of the slag was discovered, such that with more base C, Si, and Mn were eliminated from the metal, whilst with more acid C could still be eliminated, but Si and Mn were reduced and returned to the bath. "The Influence of Sulphur and Manganese on Steel" (Arnold and Waterhouse) and "On the Dangerous Crystallisation of Steel" (Arnold) were produced in 1903, and in the latter the author announced his now well-known method for recording results of steel under alternating stress, the stress being greater than the elastic limit instead of less, as is the case in other methods. "Acid Open Hearth Manipulation" (McWilliam and Hatfield, 1904) is another high temperature chemistry study on a 25-ton furnace, with unusual bases, in which also it was shown that the nature of the ingot is not merely a function of its composition as ordinarily determined, but varies with the history of the charge in a special manner shown. "The Thermal Transformations of Carbon Steels" (Arnold and McWilliam, 1904), too complex to describe in a sentence, shows the nature of the transition forms of the constituents of steels by quenching so as to trap several forms in one small section, where they can be studied somewhat after the manner of examining rock changes over a tract of country. Winder and Brunton did early work on open hearth chrome steel castings; Longmuir here worked out what had been borne in upon him by his works experience, resulting in his two researches on "The Influence of Casting Temperature on the Properties of Metals and Alloys"; Baker did his work on "The Influence of Silicon on Iron," and half the work resulting in Ibbotson and Brearley's well-known book on "The Analysis of Steel Works Materials" is of this laboratory. The above is not by any means a complete list, but is intended to indicate the principal and to give a good idea of the original work done, which has been acknowledged by practical as well as by professional men to have had great and important influence.

With regard to the students trained, every works of any importance in the district has its quota of them, and many are reflecting great credit on their school by the success with which they are holding responsible positions. There is no doubt that all firms of importance, having ready at hand well-trained men, formed a potent factor in the signal success with which Sheffield not only repelled the American invasion of high speed steel, but was able promptly and successfully to carry the war into the enemy's territory. The associateship in metallurgy has always been kept up to about the standard of an honour examination, no second classes being allowed, and the fight for the Mappin medal and 15*l*. premium given to the head associate of the year is long and severe. This medal and premium was founded by Sir Frederick Mappin, Bart., who has consistently for more than twenty years used not only his wealth, but his great influence with others, and his foresight and dogged perseverance, in furthering the cause of this technical department. His recent purchase and practical presentation of the adjacent Caledonian Works has enabled the authorities to apply their fifteen years' experience during the erection of a new and magnificent teaching plant, which has been so recently described that it need not have further mention here. Finally, as to the attitude of manufacturers, few who followed with interest the doings of fifteen years ago would have prophesied that steel makers would send for associates at the end of each session, or that some even would ask for "your medallist of the year if possible," but such is the fact to-day.

All Sheffielders asked feel certain that but for the continued success of this and the technical department as a whole, Sheffield would never have successfully demanded a university, and that, indeed, the university inaugurated by the King on July 12, 1905, may be taken as a monument to one of the influences of the technical department. Twice in its history has this progressive department had to sever its connection with constituted authority, and many are looking, somewhat anxiously it must be confessed, to its progress under the cumbrous machinery of university government, with its several forms of outside interference. Change and progress are not now decided upon by those immediately interested, for at least a majority of a governing body, composed of professors of all and sundry, must sanction all decisions, and in its effect on this hitherto uniformly progressive and successful department university government is undoubtedly on its trial, so far as its influence on the application of science to industry is concerned.

EARTH-EATERS IN INDIA.

UNDER the name of geophagy or earth-eating are comprehended a number of customs of very different origin and meaning. In practically every part of the world is found the habit of eating finely divided mineral substances in bulk, and not merely in small quantities as condiments; but the purpose differs no less widely than the condition of the eaters as regards age, sex, or health before and after acquiring the habit. We learn from Pliny that the Romans mixed corn with chalk from near Puteoli; Lemnian and Armenian earths, on the other hand, were famous for medicinal purposes—the use of the former has been continued to our own day; in South America clay supplies the place of food during floods; in Borneo and